Ephemeris of the Satellite of Neptune, 1886–87. By A. Marth.

Greenwich Noon. 1886.	P′	*a*	*b*	*u*−U	Diff.	U	B
	°	″	″	°	°	°	°
Sept. 30	323·87	16·78	8·07	35·96	612·42	131·25	−28·77
Oct. 10	323·73	16·85	8·09	288·38	·37	131·44	28·70
20	323·54	16·90	8·10	180·75	·33	131·67	28·62
30	323·35	16·94	8·09	73·08	·30	131·93	28·53
Nov. 9	323·12	16·97	8·08	325·38	·28	132·22	28·42
19	322·89	16·97	8·05	217·66	·27	132·51	28·31
29	322·67	16·96	8·01	109·93	·27	132·80	28·19
Dec. 9	322·46	16·93	7·97	2·20	·29	133·08	28·08
19	322·27	16·89	7·92	254·49	·32	133·33	27·97
29	322·10	16·83	7·87	146·81	·36	133·55	27·88
1887 Jan. 8	321·97	16·75	7·81	39·17	612·39	133·72	−27·80
18	321·87	16·67	7·76	291·56	·44	133·84	27·74
28	321·82	16·58	7·71	184·00	·50	133·90	27·71
Feb. 7	321·81	16·49	7·66	76·50	·56	133·91	27·70
17	321·85	16·39	7·62	329·06	·62	133·86	27·70
27	321·93	16·30	7·59	221·68	·68	133·75	27·73
Mar. 9	322·06	16·21	7·56	114·36	·73	133·58	27·79
19	322·23	16·13	7·54	7·09	612·78	133·36	27·87
29	322·43	16·05	7·53	259·88		133·09	−27·97

P′ angle of position of the minor axis of the satellite's apparent orbit, in the direction of superior conjunction.

a, *b*, major and minor semi-axes of the apparent orbit.

u−U, longitude of the satellite in its orbit, reckoned from the point which is in superior conjunction with the planet or in opposition to the Earth.

U + 180°, planetocentric longitude of the Earth, reckoned in the satellite's orbit from the ascending node on the celestial equator.

B, planetocentric latitude of the Earth above the plane of the satellite's orbit.

The values of P′, *a*, *b* and *u*−U are to be interpolated for the times for which the apparent positions of the satellite are required, the equation of light being already taken into account in the ephemeris, and the position-angles *p* and distances *s* are then found by means of the equations.

$$s \sin (P' - p) = a \sin (u - U)$$
$$s \cos (P' - p) = b \cos (u - U).$$

The satellite moves in the direction of *de*creasing position-angles, and will be at its greatest elongations and at its nearest

conjunctions with the planet about the following hours, Greenwich mean time:—

	Super. Conj. $p=$ P′, $s=$ *b*		*sp.* Elong. P′−90° *a*		*Infer.* Conj. P′−180° *b*		*nf.* Conj. P′+90° *a*	
1886.		h		h		h		h
Sept.	29	9·9	Sept. 30	21·2	Oct. 2	8·4	Oct. 3	19·7
Oct.	5	7·0	Oct. 6	18·3	8	5·5	9	16·8
	11	4·1	12	15·3	14	2·6	15	13·9
	17	1·2	18	12·4	19	23·7	21	11·0
	22	22·3	24	9·5	25	20·8	27	8·1
	28	19·1	30	6·6	31	17·9	Nov. 2	5·2
Nov.	3	16·5	Nov. 5	3·7	Nov. 6	15·0	8	2·3
	9	13·6	11	0·8	12	12·1	13	23·4
	15	10·7	16	22·0	18	9·2	19	20·5
	21	7·8	22	19·1	24	6·4	25	17·6
	27	4·9	28	16·2	30	3·5	Dec. 1	14·7
Dec.	3	2·0	Dec. 4	13·3	Dec. 6	0·6	7	11·9
	8	23·1	10	10·4	11	21·7	13	9·0
	14	20·2	16	7·5	17	18·8	19	6·1
	20	17·4	22	4·6	23	15·9	25	3·2
	26	14·5	28	1·7	29	13·0	31	0·3
1887.								
Jan.	1	11·6	Jan. 2	22·8	Jan. 4	10·1	Jan. 5	21·4
	7	8·6	8	19·9	10	7·2	11	18·5
	13	5·7	14	17·0	16	4·3	17	15·6
	19	2·8	20	14·1	22	1·4	23	12·6
	24	23·9	26	11·2	27	22·4	29	9·7
	30	21·0	Feb. 1	8·2	Feb. 2	19·5	Feb. 4	6·8
Feb.	5	18·0	7	5·3	8	11·6	10	3·8
	11	15·1	13	2·3	14	13·6	16	0·9
	17	12·1	18	23·4	20	10·6	21	21·9
	23	9·2	24	20·4	26	7·7	27	18·9
Mar.	1	6·2	Mar. 2	17·4	Mar. 4	4·7	Mar. 5	15·9
	7	3·2	8	14·5	10	1·7	11	13·0
	13	0·2	14	11·5	15	22·7	17	10·0
	18	21·2	20	8·5	21	19·7	23	7·0

Since the last ephemeris of the satellite was published, some weighty evidence concerning the position of the plane of its orbit has become available by the publication of Appendix II. of the Washington Observations for 1881, containing Asaph Hall's paper, "Orbit of the Satellite of Neptune." The question of the position of the plane is a perplexing one. When, in 1865,

I had made a determination of the orbit from the Malta observations of 1863–64, it was to me a puzzle what could be the cause that the values of the node and inclination which, ten years before, I had deduced from Lassell's observations of 1852 ($N = 178°{\cdot}74$, $I = 126°{\cdot}14$ for 1852·9) should differ from those of the later determination ($N = 181°{\cdot}49$, $I = 123°{\cdot}86$ for 1864·0) considerably more than the agreement of the measurements of each series, as shown by the probable errors, seemed to permit. The circumstance, that in 1863–64 the form of the apparent orbit was that of a narrow ellipse, favoured the determination of the inclination and node, but was disadvantageous for fixing the satellite's orbital longitude, which was, indeed, left practically indeterminate. Hence my investigation could be only a preliminary one, till further observations should allow the question of orbital longitude to be settled, and I abstained the more readily from publishing merely preliminary results, as at that time I was led to expect that before long I should myself have the opportunity of making the observations requisite for a more complete investigation. When Newcomb's paper, "The Uranian and Neptunian Systems," forming Appendix I. of the Washington Observations for 1873, became known to me, I was surprised that his values of the node and inclination ($N = 183°{\cdot}03$, $I = 121°{\cdot}70$ for 1874·0) differed from those derived from the Malta observations of 1863–64 in the same direction as these differed from the values found from the earlier series. Making ample allowance for any plausible or possible errors of the Malta observations, I satisfied myself that in 1863–64 the satellite could not have moved in the plane deduced from the Washington observations. However, in the ephemerides published in the *Monthly Notices*, I thought it best to adopt Newcomb's determination, leaving the difficulty to be cleared up by the evidence of further observations. The measurements from other observatories have hitherto been too sporadic to be of real help. But Asaph Hall's "Orbit of the Satellite of Neptune" contributes sufficient evidence to justify a public statement in order to call the attention of astronomers to the consideration of a very perplexing question.

If Hall's values of the node and inclination ($N = 184°{\cdot}316$, $I = 120°{\cdot}052$ for 1883·0) and the values before-mentioned are transferred from the planes parallel to the terrestrial equator, to which they refer, to the plane of the orbit of Neptune ($N_0 = 3°{\cdot}568$, $I_0 = 22°{\cdot}339$ for 1880·0), the four determinations furnish the following values of the node and inclination of the satellite's orbit in reference to that of the planet, the longitudes of the node being reckoned along the planet's orbit from the point which precedes the ascending node of the orbit on the ecliptic by $130°{\cdot}437$, the ecliptical longitude of this node. If reckoned from the ascending node N_0 of the planetary orbit on the equator, the longitudes of the node are $3°{\cdot}29$ less. The probable errors of the values amount only to a few tenths of a

degree, and may be left unnoticed at present, as they and their differences do not affect the question at issue.

		Long. of Node on Neptune's Orbit.	Inclination of the two Orbits.		
Malta	1852	176°·20	148°·33 or	31°·67	if the satellite's motion is reckoned as retrograde.
	1864	180·41	146·19	33·81	
Washington	1874	182·59	144·04	35·96	
	1883	184·31	142·38	37·62	

How are the differences of these values to be explained?

Can they be accounted for by any plausible or possible systematic errors in the observations?

Or do they represent real changes in the position of the plane of the orbit, the effect of some disturbing force which must be found out and traced to its source? What plausible cause can produce such changes? That is the question.

In order to proceed with due caution in this investigation, it is obviously desirable that the available evidence should be strengthened. Considering that a number of sufficiently powerful telescopes, firmly mounted, and provided with superior micrometers, are in existence, is it too much to ask that they should be employed during the present apparition of Neptune at every favourable opportunity in measuring the position-angle and the distance of the satellite (or, if both co-ordinates cannot be got, at least the position-angle), so that, from their united evidence, not only the elements of the orbit may be determined for the present time, but also some evidence may be gained for the consideration of the question of systematic errors? Observers must, of course, be on their guard against any preoccupation or bias, and it may be hoped that the publication of the observations will not be needlessly delayed.

The ephemeris has been computed with the same elements as in preceding years, so that the satellite is assumed to move in the plane of Newcomb's elements for 1874. The variations of the ephemeris if the plane of Hall's elements for 1883, or that derived from the Malta observations, is substituted may be recognised from the following data:—

	Washington 1883.			Malta 1864.		
	P′	U	B	P′	U	B
	°	°	°	°	°	°
1886, Sept. 30	321·74	132·90	−29·30	326·52	129·20	−27·90
Nov. 29	320·53	134·43	28·67	325·34	130·77	27·39
1887, Jan. 28	319·68	135·52	28·15	324·49	131·89	26·95
Mar. 29	320·29	134·72	−28·44	325·09	131·07	−27·18

Errata in Mr. Tebbutt's paper, "Observations of Double Stars at Windsor, N. S. Wales," in *Monthly Notices*, vol. xlvi :—

Page 51.—Position angle of Lac. 1181, *for* 227°·5 *read* 327°·5.
,, 52.—*For o* Argûs *read v* Argûs.

Erratum in Mr. Backhouse's paper, "The Great Shower of Andromedes, 1885," in *Monthly Notices*, vol. xlvi :—

Page 310, last line of Table I., in column "duration of watch," *for* 78 *read* 98.